Orbit mysteries:clues and cures

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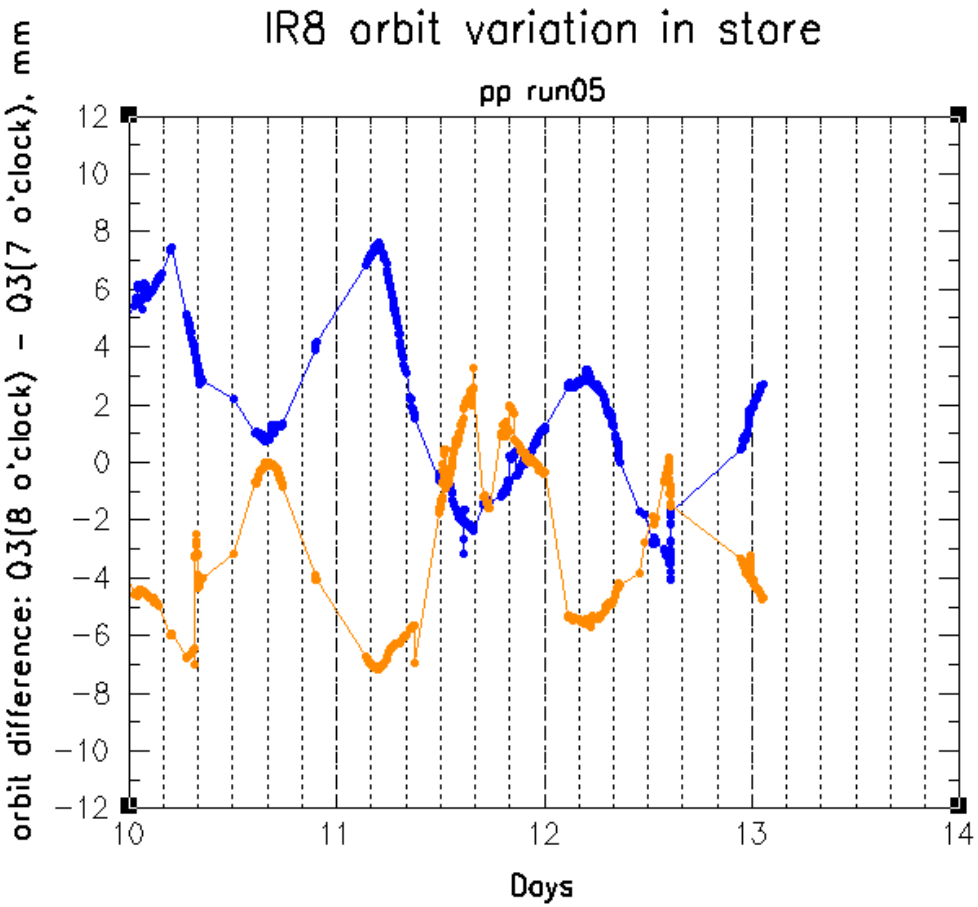
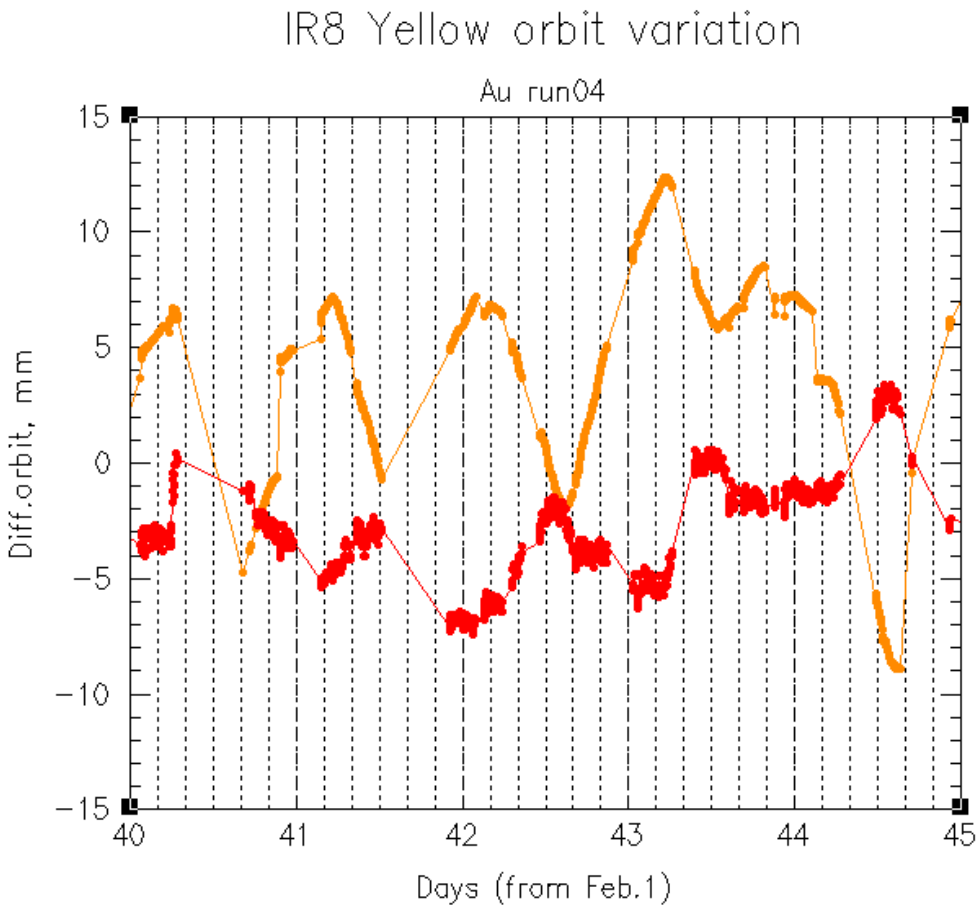
- Orbit variation with time
- Orbit and dispersion
- Misalignments
- Orbit correction issues

Orbit variation with time

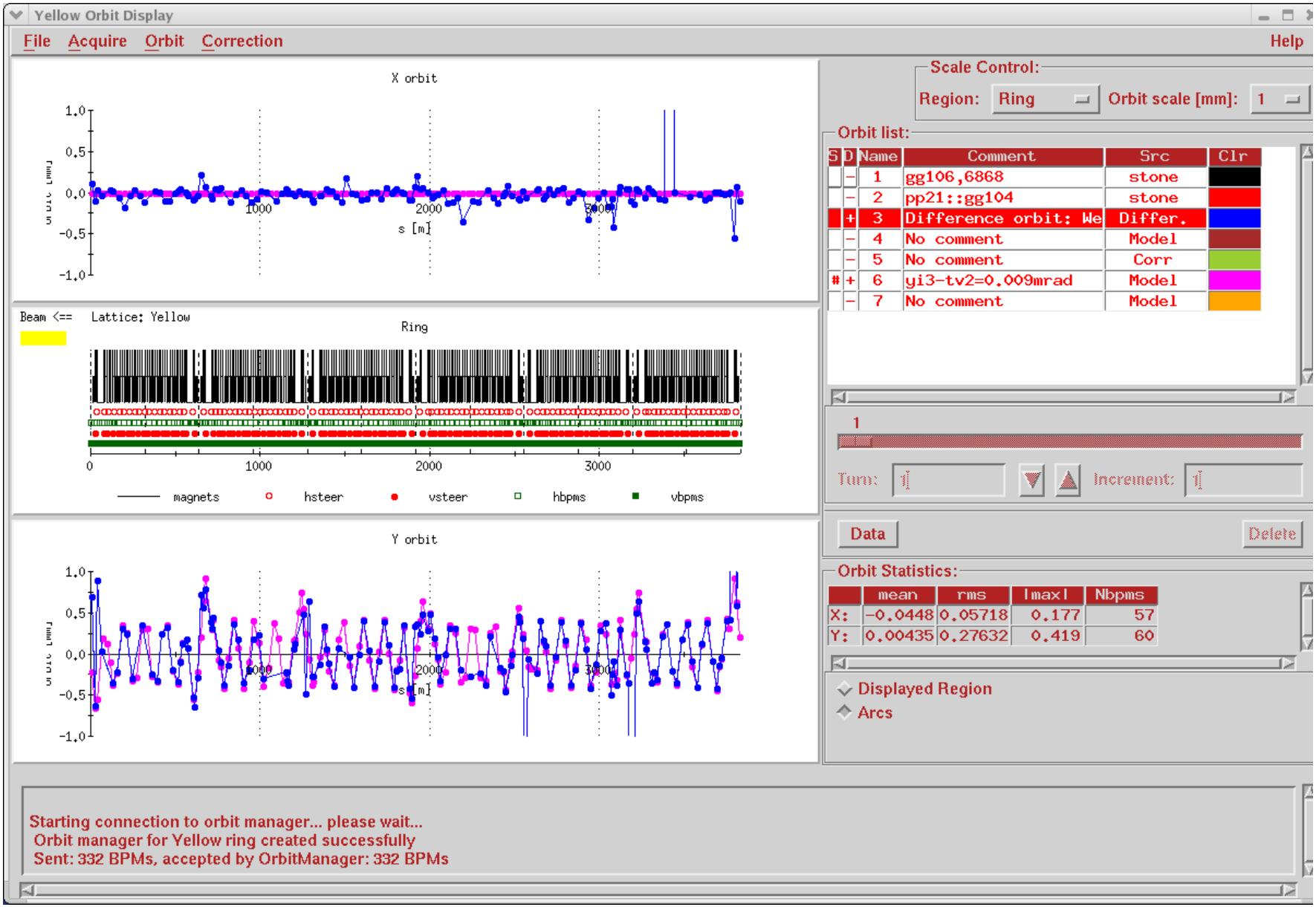


- The orbit variation with time in both rings was observed this year first during Cu run and then through the whole pp run.
- The variation is over the whole ring but the largest effect seen in IR8
- Larger effect seen in vertical plane.
- Exactly 1 day period.
- Maximums and minimums at 4-5am and 4-5pm (on later data at 6am(pm)!)

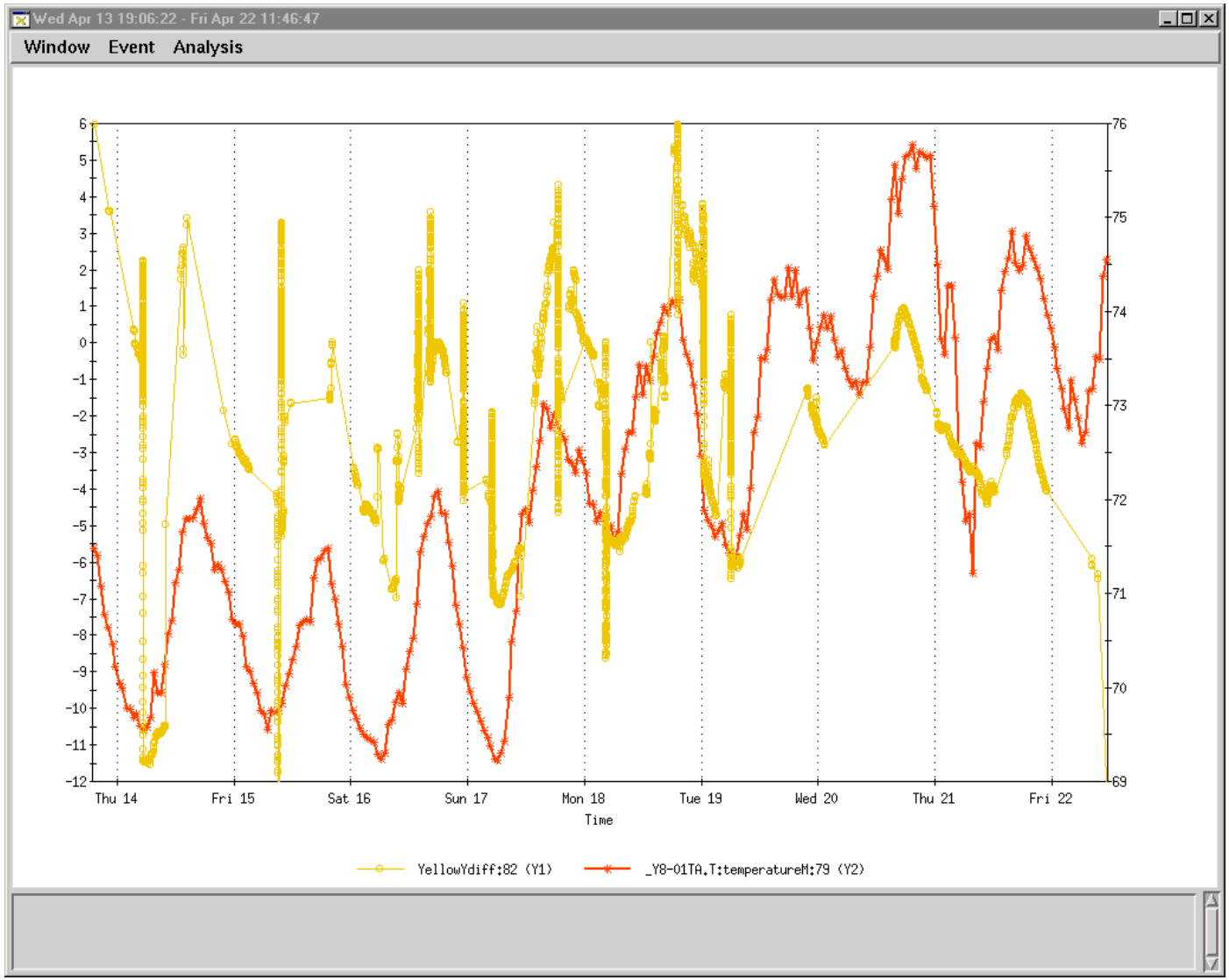


Similar variation was present in last year run but left unnoticed.

From fitting the data, source of the variation is at IR4 (3o'clock side)



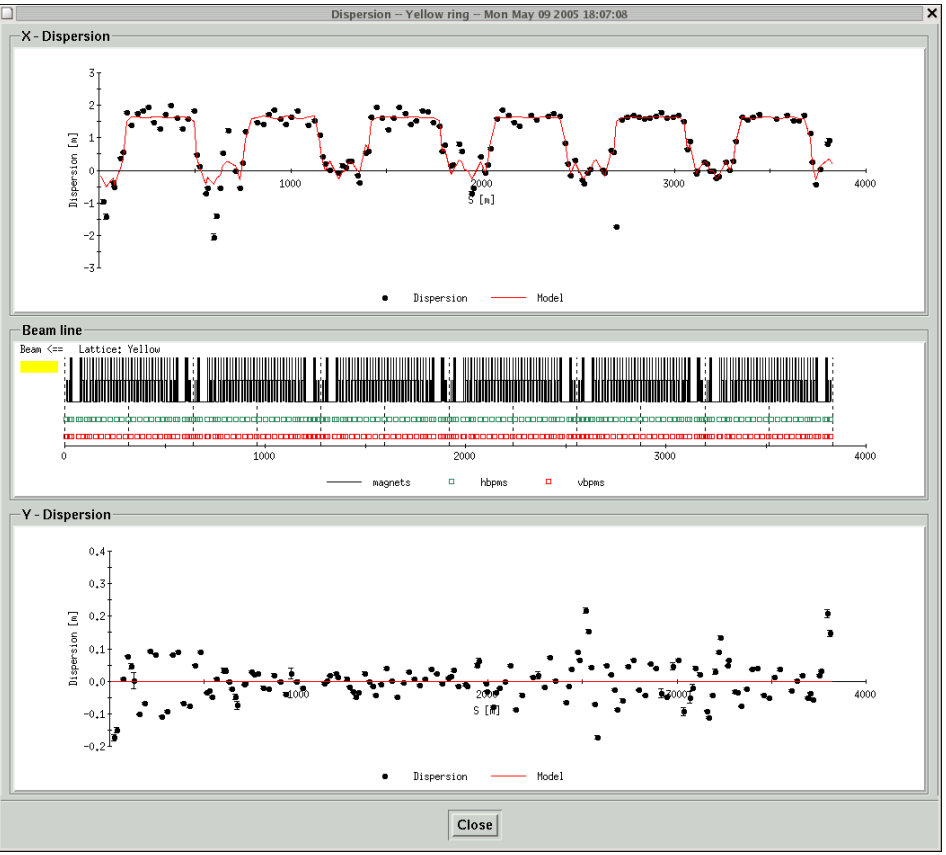
Similar variation were seen on some temperature data from ring and service buildings (J.Morris, D.Bruno). Though not yet definite conclusion.



Yellow dispersion measurements done for different orbit angles

$$(\delta D)'' + g(\delta D) = g x_{co} - r$$

IP6 0.28mrad (IP8 -0.28mrad is similar)



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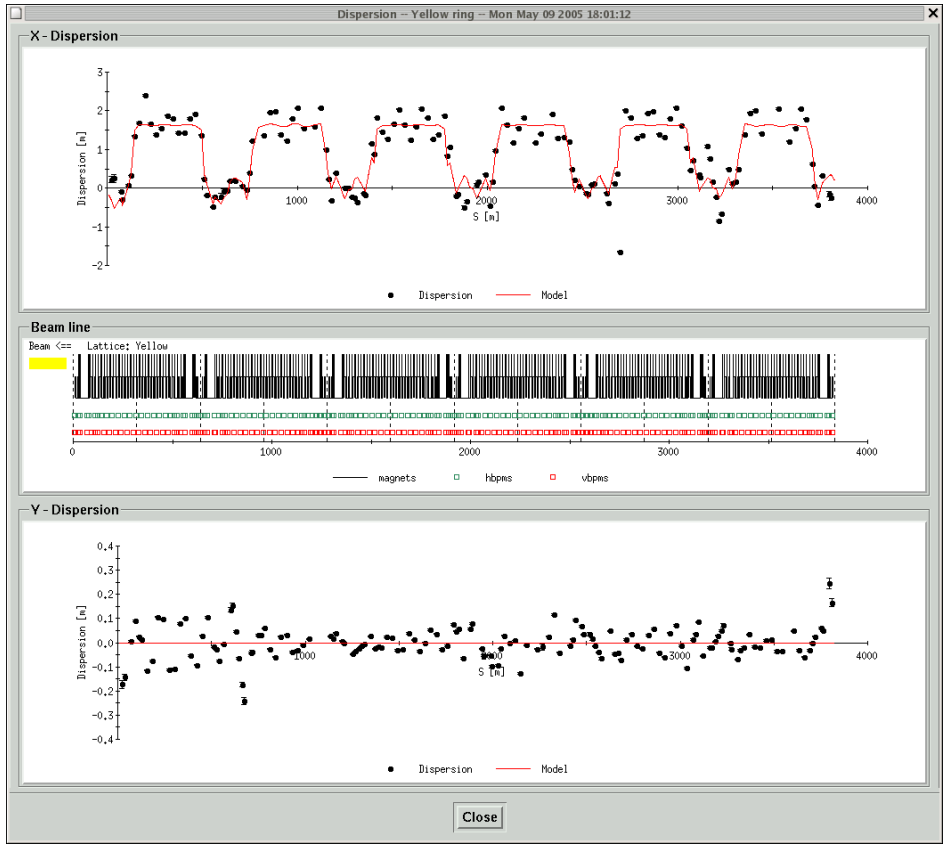
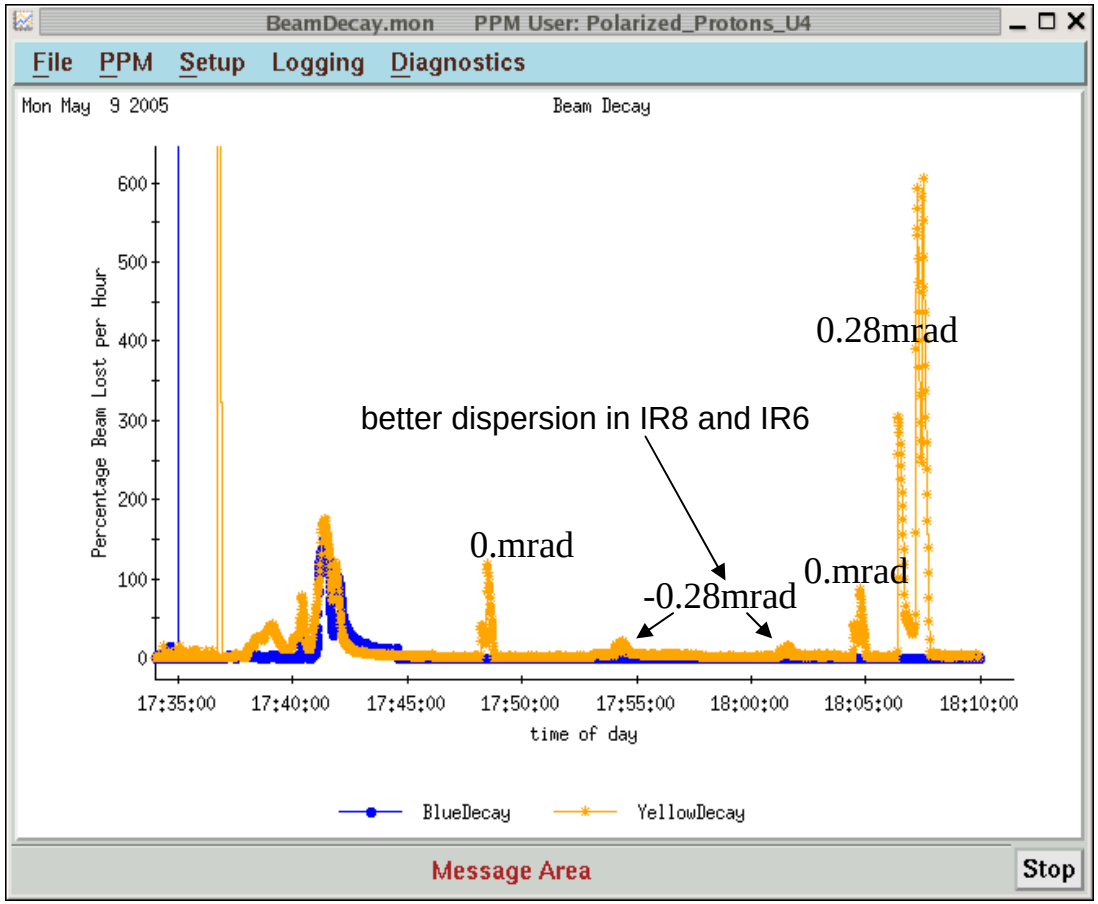


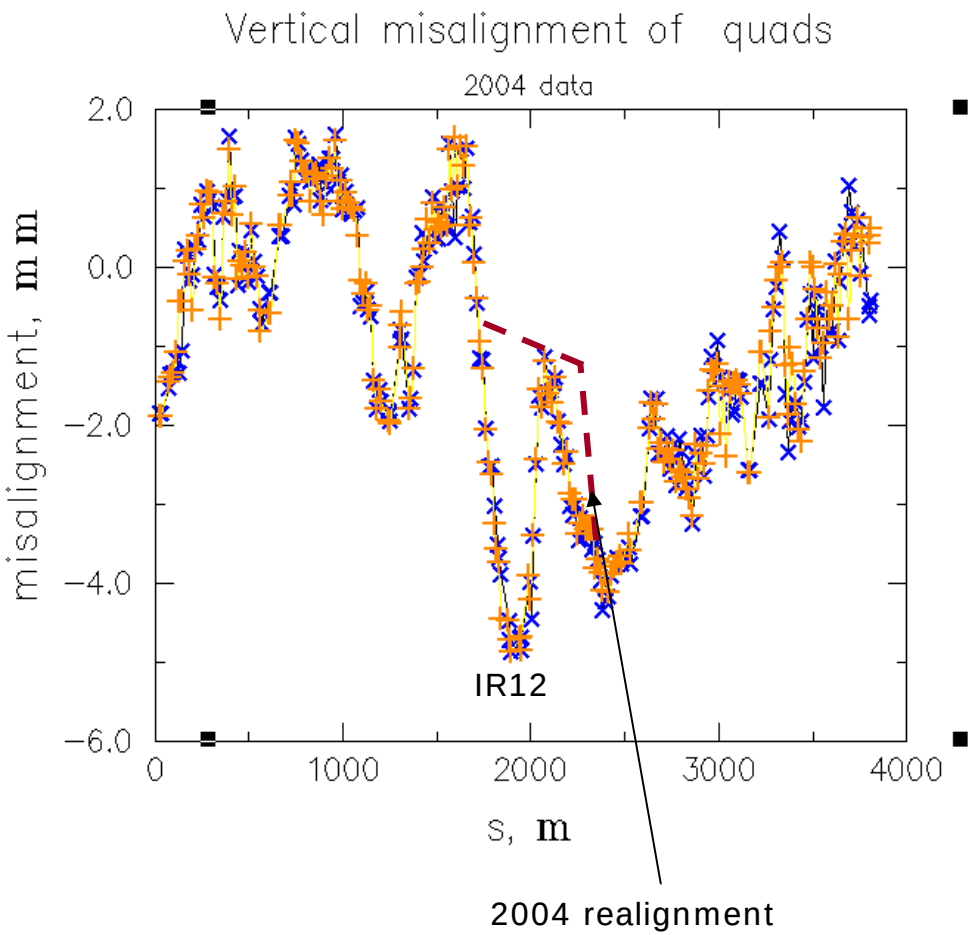
Dispersion versus orbit



Yellow beam decays during +-0.7mm radial changes at different Values of orbit angle in IP6

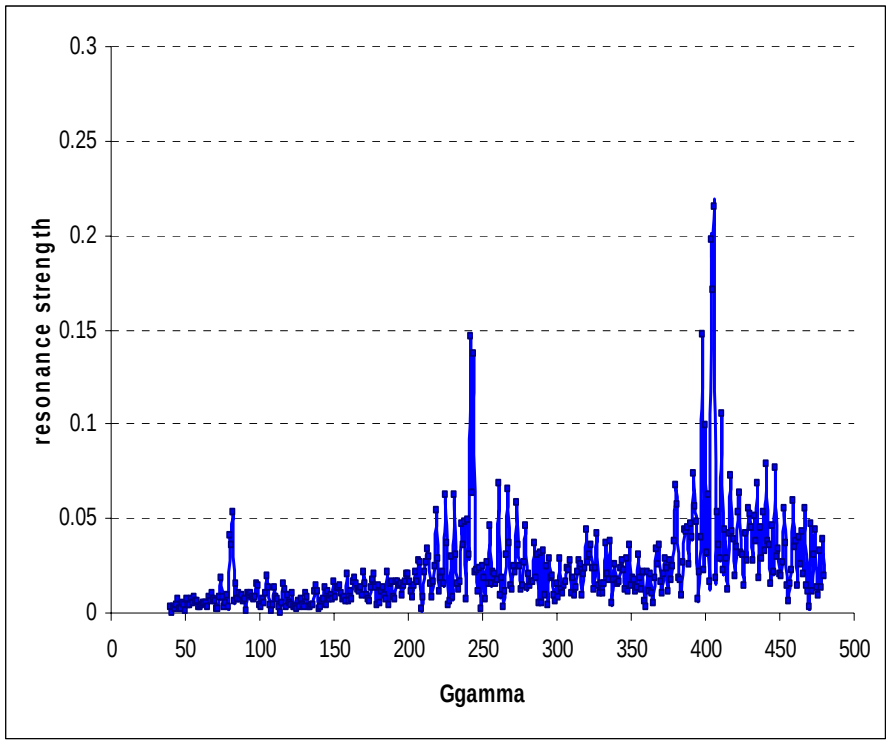
- Momentum aperture depends on dispersion functions which in turn depend on closed orbit changes and strongly asymmetric relative to the orbit angle bumps in IR6 andn IR8.
- Dispersion function correction algorithm should be developed to provide the correction in best way.
- The orbit correction (and IR steering?) should take into account and calculate dispersion function changes.
- Ultimately: doing orbit and dispersion correction in the same time
- Updating model and model-ROD interface to realize these tasks (Nikolay).

Quad-to-Quad misalignments



- Misalignment oscillations at the level of few mm.
- Misalignment dips are at the interaction regions.
- Flat orbit is the best for for polarization preservation.
- Some sections of the ring as well as several individual quadrupoles have been realigned in 2002 and 2004.

Resonance strength for the flat orbit



Vertical orbit corrrected to the plane in vertically focusing quads.
No correctors in defocusing quads, so there are orbit excursions there.

Resonance strength tolerance is at 0.05 level at high energy end.

Strong resonances at (2k+1)*81

3*27

superperiodicity

cells per superperiod

Optics issues: off-center in sextupoles -> strong coupling, dQmin~0.03

Getting to the flat orbit

- Ultimately: ring realignment will do the job of making the orbit (perfectly) flat.
- Otherwise: the construction of the flat orbit would require for more delicate approaches:
  - Subtract low harmonics of misalignment data
  - Or, subtract sliding averages fo misalignment data
  - Or/And consider orbit harmonic correction of largest harmonics of misalignment data

Orbit correction issues, BPMs

- Modification done in BPM system clearly improved the quality of the orbit correction.

  No overcorrection problem anymore! The measured orbit after correction is in exact agreement with the predicted (calculated) orbit.

- Remaining issue: BPM offsets which were seen in IRs and Q7-Q8 regions.

  Many of them (but not all) have been fixed with BBA (Todd)

Orbit Correction, Sliding Bumps

- With improved BPM system, SB correction provides the orbit rms at ~0.1mm level. (With more iterations should be even better).

- Major issue: considerable tune and coupling changes caused by SB correction.

  Caused by sextupole fields in dipoles and sextupole correctors.

- Present approach is making the correction in several (2-4) steps in order to provide corresponding tune (and decoupling) adjustments.

- Required upgrade: model predictions for the tune and coupling produced by the orbit correction (work is underway, Nikolay).

  Ultimately, simultaneous adjustments of tune as well as skew quadrupole families during the orbit correction.

Orbit correction, Best Corrector

- Used for simple orbit correction and (by Ramp Correction) to prevent the orbit rms deterioration with time.

- By itself can not improve the orbit rms below certain level (0.7 - 1.5mm). It is clear already how the algorithm can be improved to provide better efficiency of the correction (but not realized yet).

- Efficiency of Ramp Correction is affected by the orbit variation with time (especially with long stores).

  Present strategy is to make the correction with the orbit acquired in 7am-1pm and 7pm-1am time intervals. Should be thought more on this.

Summary

- Orbit variation puzzle should be analyzed more to look for possible explanations.
- Ring realignment (?)
- Upgrades for orbit correction:
  - Dispersion variation with the orbit
  - Tune and coupling variation with the orbit
  - Improved BestCorrector